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ORIGINAL ARTICLE

Body mass index and its impact on outcomes in CABG surgery: the paradox of obesity and underweight risks.

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ABSTRACT… Objective: To explore the impact of BMI on the short-term mortality and morbidity of patients undergoing CABG. **Study Design:** Retrospective Cross Sectional study. **Setting:** Department of Cardiac Surgery Rehman Medical Institute, Peshawar, Pakistan. **Period:** 1st June 2017 to 31st December 2022. **Methods:** The data was collected from the data base of the cardiac surgery department. **Results:** Total of 2599 isolated CABG patients were included with mean age of 57.86±9.2 years. The majority was overweight (42%). Approximately 78.1% were male. Hypertension was our dominant co-morbidity (68.7%) followed by dyslipidemia (65.4%) & DM (50.1%). Majority of patients had NYHA-III symptoms (51.2%). A significant proportion of individuals who are classified as underweight are elderly. Generally, there is a significant increasing trend of DM & HTN incidence with increasing BMI. In terms of intra-operative parameters there is increasing trend of intra-operative transfusions and higher rate of IABP insertion in underweight patients. Generally the underweight patients has the higher trend of adverse outcomes (e.g., prolonged mechanical ventilation, blood product requirement, reopening & re-intubation), but not significant. However, they have significantly longer mechanical ventilation time compared to normal. On the other extreme, morbidly obese patients had the highest in-hospital mortality (11.3%) while overweight had the lowest (2.6%) with a P-value of 0.008. Multivariate regression analysis showed that mean age (P 0.034), cross-clamp time (P 0.018) & mechanical ventilation (P <0.001) were significantly associated with in-hospital mortality. **Conclusion:** Morbidly obese patients undergoing CABG surgery face significantly higher in-hospital mortality rate, conversely overweight patients exhibits the lowest mortality rates confirming a partial obesity paradox. However, underweight patients experience the worst outcomes, including increased requirements for postoperative blood transfusions, a higher incidence of surgical reopening, and significantly extended mechanical ventilation hours, which indicates either extreme of BMI group is associated with worst outcomes.

Key words: Body Mass Index, CABG (Coronary Artery Bypass Grafting), Mortality, Obesity, Outcomes.

INTRODUCTION

The BMI (body mass index) categorizes a patient according to weight in kilograms divided by height in meters squared (kg/m2). Obesity has been associated with conditions such as diabetes and hypertension among other conditions in a 10-year prospective cohort study on Asian-Indians concluding centrally obese individuals having a 1.95 and 2.19 times higher risk of developing diabetes and hypertension.[1] Sedentary lifestyle & growing habits of eating fast food is responsible for rising prevalence of obesity among adolescents.[2] The relationship between obesity and cardiovascular outcomes has been previously studied such as in the meta-analysis.[3] The increased incidence of wound infection post-CABG in obese patients has also been previously studied.[4] However, we sought to compare a wide range of peri-operative parameters according to the patient's BMI, as well as obesity paradox in patients undergoing CABG. The obesity paradox hypothesizes that patients who are considered to be overweight but not morbidly obese have better mortality outcomes than underweight and normal BMI categories.[5] Numerous studies have shown patients with a U-shaped relationship

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between BMI group and mortality.[6,7] Although there is evidence for the existence of the obesity paradox, some studies have cast doubt on this phenomenon such as Hisato Takagi et al, demonstrating a statistically significant difference in short-term and mid-to-long-term outcomes between overweight and normal patients.[10] A meta-analysis by Raul A. Borracci et al, which studied the association of BMI with short-term outcomes after cardiac surgery, concluded the same results, however obese patients had higher rates of complications.[11] We aimed to study the frequency of perioperative morbidity & mortality in patients who underwent CABG according to their BMI groups to gain a better understanding of any link between the aforementioned complications and their groups.

METHODS

Data was retrieved from the database of the cardiac surgery department at a Rehman Medical Institute for patients who had undergone CABG. Only patients that underwent isolated CABG were included whilst patients that underwent concomitant CABG such as CABG with valvular or congenital heart disease were excluded. A total of 2599 patients from 1st July 2017 until December 31st, 2022 met the criteria. Ethical approval (RMI/RMI-REC/ARTICLE APPROVAL/73- May 10, 2023) was granted by the ethical review board of the hospital. Patients were then categorized according to their BMI groups. The peri-operative variables were extracted from the data, collected through a pre-designed pro forma. Tables and graphs were made using Microsoft Excel. Data were analyzed using IBM SPSS 21.0. Frequencies and percentages were calculated for qualitative variables. Mean and standard deviation was calculated for quantitative variables. For statistical analysis, the Chi-square & independent t-test was employed. Multi-linear regression analysis was done to obtain the association between parameters and in-hospital mortality. A P-value of <0.05 was considered statistically significant. The term "outcomes" mean the early in-hospital outcomes with in the same admission. In-hospital Mortality was considered the primary outcome and secondary outcomes included perioperative morbidity. The term "in-hospital mortality" refers to fatalities that occur during the hospital stay following surgery within the index hospital admission. The parameters for prolonged ventilation were longer than 24 hours and prolonged ICU stay as longer than 48 hours. BMI categorization was done as follows[1]:

Underweight: <18.5
Normal weight: 18.5–24.9
Pre-obesity (overweight): 25-29.99
Obesity class I (mildly): 30-34.99
Obesity class II (moderately): 35-39.99
Obesity class III (morbidly): >40

RESULTS

Baseline characteristics, pre-, intra-, and post-operative parameters have been represented in table and graph form (Table-I,II)

The study included 2599 patients who underwent isolated CABG with a mean age of 57.86±9.2 years. Overweight patients accounted for 42% the highest percentage, while underweight made up the least (1.4%). All the BMI groups had significant age differences when compared (P<0.001). Underweight made up the oldest (59.44±11.54) whilst morbidly obese made up the youngest patients (54.97±8.3).

In terms of co-morbidities, patients in the Obese-II had the highest percentage of diabetics (63.9%) while underweight had the lowest (40.5%). The incidence of diabetes increases significantly with obesity (0.002). Family history of coronary artery disease showed incremental increases from patients categorized as normal to obese-II peaking at 5% which is statistically significant (0.05). Hypertension was the most common co-morbidity (68.7%). There is a significant increase in the incidence of hypertension with obesity (<0.001) with the highest incidence amongst obese II (84%). Dyslipidemia is the 2nd more common co-morbidity (65.4%) with morbidly obese patients making up 78.2%. In terms of clinical presentation, majority of patients were categorized as NYHA-III (51.3%). The majority of underweight patients had impaired pre-operative ejection fraction (EF<50%) (61.1%) while the majority of morbidly obese patients had preserved Ejection fraction (EF>50%) (65.6%). The only pre-operative parameters which showed statistically significant relationships among the groups were mean age, male gender, family history of CAD, diabetes & hypertension.

In terms of Intra-operative characteristics, use of IABP was highest amongst underweight patients (13.5%) with overweight patients making up the lowest percentage (6.7%). In underweight with low EF the incidence of IABP insertion compared with preserved EF was found to be statistically significant (0.05). Whereas the rate of IABP insertion in underweight having low EF when compared with morbidly obese with low EF was found to be of no significance (P=0.9). Use of blood products was also highest amongst underweight patients making up 67.5% and lowest amongst obese-II (52.9%). Morbidly obese patients had the longest cross-clamp times (58.0±30.0). Our study showed no statistical significance among the intraoperative parameters with BMI groups.

Lastly, patients were also categorized for postoperative outcomes according to their BMI group. The mean mechanical ventilation time was showing statistically significant difference amongst the groups, with underweight patients (14.8±41.8) having extended hours of ventilation while normal BMI patients (7.32±8.9) having the minimum hours. Post-operatively, underweight patients having the higher trend of blood / products transfusion (54.1%) with the highest percentage of reopening (13.5%) however none of them were statistically significant. Obese-II patients required prolonged post-operative ventilation (5.9%) and morbidly obese required the least (1.6%). Post-operative mortality seemingly followed a J-shaped relationship between BMI groups with morbidly obese patients who had the highest mortality at 11.3% whereas overweight patients had the lowest 2.6% which was significantly less than the highest group (P 0.008).

A multilinear regression analysis of different parameters was done to obtain an independent association with in-hospital mortality, which showed an association of age, mechanical ventilation & cross-clamp time with in-hospital mortality with a P value of 0.034, <0.001 & 0.018 respectively.

	Parameter	Underweight (BMI < 18.5)	Normal (BMI 18.5 - 24.9)	Overweight (BMI 25 - 29.99)	Obese I (BMI 30 - 34.9)	Obese II (BMI 35 - 39.9)	Morbid obesity (BMI 40.0+)	P-Value
	N=2599	37 (1.4%)	778 (29.9%)	1092 (42.0%)	511 (19.7%)	119(4.6%)	62(2.4%)	
1	Age (Mean ±S.D)	59.4 ±11.5	59.45±9.04	57.6±9.1	59.35±9.2	56.72±8.8	54.9±8.3	<0.001
2	Male	27(73.0%)	627(80.6%)	881(80.7%)	384(75.1%)	75(63.0%)	37 (59.7%)	<0.001
3	Tobacco Use	7 (18.9%)	127(16.3%)	182 (16.7%)	104 (20.4%)	16 (13.4%)	6 (9.7%)	0.16
4	Diabetes	15(40.5%)	359(46.1%)	574(52.6%)	244(47.7%)	76(63.9%)	33 (53.2%)	0.002
5	Family History CAD	1 (2.7%)	15 (1.9%)	43 (3.9%)	25 (4.9%)	6 (5.0%)	1 (1.6%)	0.05
6	Hypertension	27 (73.0%)	500 (64.3%)	744 (68.1%)	371 (72.6%)	100 (84.0%)	45 (72.6%)	<0.001
7	Dyslipidemia	17 (58.6%)	366 (65.4%)	483 (44.9%)	244 (65.3%)	57 (69.5%)	36 (78.2%)	0.4
8	NYHA I	2 (5.4%)	27 (3.8%)	36 (3.6%)	26 (5.6%)	7 (6.0%)	1 (1.6%)	0.329
9	NYHA II	3 (8.1%)	139 (19.8%)	205 (20.8%)	98 (21.1%)	21 (18.2%)	11 (18.3%)	0.680
10	NYHA III	23 (62.1%)	391 (55.6%)	556 (56.6%)	262 (56.4%)	64 (55.6%)	33 (55%)	0.776
11	NYHA IV	7 (18.9%)	145 (20.6%)	185 (18.8%)	78 (16.8%)	21 (18.2%)	11 (18.3%)	0.757
12	Low EF ≤50%	22 (61.1%)	386 (50.5%)	484(44.7%)	228 (45.6%)	45 (37.8%)	21(34.4%)	0.135
13	Preserved EF>50%	14 (38.9%)	378(49.5%)	598(55.3%)	272 (54.4%)	74 (62.2%)	40(65.6%)	0.494

NYHA= New York Heart Association, EF=Ejection Fraction, CAD- Coronary Artery Disease

Table-I. Relationship of BMI with preoperative patient's parameters

	Parameter	Underweight (BMI < 18.5)	Normal (BMI 18.5 - 24.9)	Overweight (BMI 25 - 29.99)	Obese I (BMI 30 - 34.9)	Obese II (BMI 35 - 39.9)	Morbid obesity (BMI 40.0+)	P-Value
	N=2599	37 (1.4%)	778 (29.9%)	1092 (42.0%)	511 (19.7%)	119 (4.6%)	62 (2.4%)	
1	Perfusion time mean ± S.D (mins)	102.5 ±45.7	96.8 ±34.4	96.97 ±31.3	96.5 ±26.7	98.6 ±33.3	102.9 ±45.6	0.5
2	X-Clamp time Mean ± S.D (mins)	54.6 ±21.5	55.0 ±21.6	54.3 ±20.0	52.7 ±16.2	53.8 ±21.1	58.0 ±30.0	0.2
3	IABP	5 (13.5%)	74 (9.5%)	74 (6.7%)	43 (8.4%)	9 (7.5%)	7 (11.3%)	0.2
4	Number of patients Intra-Op Blood products	25 (67.5%)	456 (58.6%)	596 (54.5%)	278 (54.4%)	63 (52.9%)	40 (64.5%)	0.1
5	ICU stay Mean± Std (hours)	54.61 ±21.5	55 ±21.6	54.5 ±20.0	52.7 ±26.6	53.6 ±20.8	51.1 ±22.0	0.5
6	Mechanical ventilation Mean± Std (hours)	14.8 ±13.8	7.32 ±8.9	7.54 ±12.0	8.2 ±12.53	7.77 ±8.71	8.51 ±13.1	0.01
7	Number of patients receiving post-op Blood products	20 (54.1%)	347 (44.6%)	478 (44.6%)	205 (40.1%)	59 (49.6%)	27 (43.%5)	0.2
8	Re-Opening for bleeding/ tamponade	5 (13.5%)	60 (7.7%)	83 (7.6%)	29 (5.7%)	10 (8.4%)	3 (4.8%)	0.39
9	Prolong Ventilation	2 (5.4%)	22 (2.8%)	27 (2.5%)	14 (2.7%)	7 (5.9%)	1 (1.6%)	0.3
10	In-hospital Mortality	1 (2.7%)	28 (3.6%)	28 (2.6%)	16 (3.1%)	6 (5.0%)	7 (11.3%)	0.008

X-clamp=Cross clamp time, IABP=Intra-Aortic Balloon Pump

Table-II. Relationship of BMI with Intra & post-operative patients parameters

Parameters	P-Value	95.0% Confidence Interval	
		Lower Bound	Upper Bound
Age (years)	0.03	.000	.001
Gender	0.8	-.014	.017
Family History of Coronary Artery Disease	0.2	-.052	.016
Diabetes	0.1	-.003	.023
Hypertension	0.1	-.025	.002
Myocardial Infarction:	0.1	-.004	.023
Mechanical Ventilation (Hours)	<0.001	.002	.003
Cross Clamp Time min (minutes)	0.01	.000	.001
Ejection fraction	0.7	-.003	.002

Table-III. Multi-linear regression analysis of factors associated with in-hospital mortality

DISCUSSION

Our findings showed that overweight patients made up the highest percentage of cohort, which corresponds with previous research such as Li C et al, Schwann TA et al.[6,7] Additionally, patients who were morbidly obese made up the youngest patients which co-related with multiple studies.[7-12] Our findings echoed previous studies with normal patients or underweight patients making up the oldest patients across various studies.[8,9,13] In terms of pre-operative comorbidity, existing research showed obese-II had the highest incidence of diabetes and hypertension followed by morbidly obese patients and similar to previous findings that underweight or normal patients had the lowest incidence of diabetes.[7,8,12] While 95.2% of the Pakistani population is generally reported to have dyslipidemia, our study found a lower prevalence rate of 65.4%. Despite this discrepancy, dyslipidemia remains the second most common comorbidity in our study.[14] M Matsuda et al pursued to further understand the mechanism behind the obesity paradox by studying endocrine factors such as adiponectin, whereby a lower BMI and higher adiponectin levels were associated with a higher risk of CV death in patients suffering from CAD.[15] Incidence of dyslipidemia and myocardial infarction was highest amongst morbidly obese patients as shown by Ville Hallberg et al[12], however, other studies such as Thomas A Schwann et al have shown normal and underweight to have the highest incidence of previous myocardial infarction.[7] We hypothesize as underweight patients were older when presenting for surgery, they were at a more advanced stage of cardiovascular disease progression. Our findings regarding underweight patients having the highest frequency of patients with an ejection fraction <50% were consistent with those reported by Thomas A Schwann et al.[7] Majority of our patients had NYHA-III symptoms which correlated with existing research.[12] Jawad H Butt et al concluded that newer indices (without weight) for patients suffering from HFrEF demonstrate that greater adiposity is associated to higher HF hospitalization risk.[16] Additionally, N Jones et al found underweight patients with HF to have the highest rates of mortality compared to overweight patients confirming an obesity paradox.[17] This may indicate a need for more stringent screening pre-operatively as well as management in a more individualized manner for underweight, overweight, and obese patients.

Cross-clamp time and perfusion time were found to be similar to Thomas A Schwann et al findings, whereby morbidly obese patients had the longest cross-clamp time in our findings.[7]

Post-operative use of blood products was highest amongst underweight patients and we hypothesize this as the cause of increased rates of re-opening in underweight patients. ICU stay was longest amongst patients categorized as normal correlating with the findings of Feridoun Sabzi et al.[13]

We strived to explore further the obesity paradox and our findings showed overweight patients to have the most favorable outcomes correlating with previous studies.[5-8] Furthermore, morbidly obese patients as having the highest rate of mortality which shares similar findings with other studies.[7] Interestingly, while other studies have found underweight & morbidly obese having the worst outcomes in a U-shaped curve, our findings showed underweight patients to have the second lowest incidence of mortality.[6] This may in part be due to a smaller sample size in comparison to other groups. Thomas A Schwann et al concluded that the obesity paradox was associated with a reduced risk of CV and non-CV mortality after fifteen years, however, this is contrasted by Ville Hallberg et al who concluded obese patients have a similar mortality risk at 20 years as normal patients with overweight patients having the better outcome.[7,12] C Gurevitz et al, in a retrospective study, sought to study 30-day MACE and one-year mortality in ACS patients according to their BMI from 2000-2018, concluding the existence of the obesity paradox and a general decrease in mortality in all groups excluding underweight patients where mortality remained consistently high.[18] Additionally, in a retrospective study, B Narasimhan et al desired to compare mortality and readmission rates in elderly obese and non-obese patients suffering from ACS which showed obese patients to have a significantly lower mortality and readmission rate indicating an obesity paradox.[19] The aforementioned studies indicate the need for further analysis of this phenomenon to provide a more comprehensive understanding. We hypothesize that as underweight patients are older and have more incidence of perioperative complications that often didn't include malnourishment screening, this would explain the higher incidence of mortality in other studies perhaps not reflected in ours due to a small sample size.[5,6,13] Additionally, studies on the same topic often excluded underweight patients where our findings have demonstrated significant findings in underweight patients.[7] As well as this, patients in some studies were not subdivided into subgroups beyond normal and were categorized together as obese or beyond overweight were categorized together as obese which made it difficult to study the occurrence of a potential obesity paradox.[13] This demonstrates the importance of including underweight patients in a study as well as subdividing obese patients rather than lumping categories together beyond overweight.

LIMITATIONS

Our study did not measure long-term mortality amongst groups. Some sample size of groups was small. Similarly single center, retrospective study design and short term outcomes were the main limiting factors.

CONCLUSION

Morbidly obese patients undergoing CABG surgery face significantly higher in-hospital mortality rate, conversely overweight patients exhibits the lowest mortality rates confirming a partial obesity paradox. However, underweight patients experience the worst outcomes, including increased requirements for postoperative blood transfusions, a higher incidence of surgical reopening, and significantly extended mechanical ventilation hours, which indicates either extreme of BMI group is associated with worst outcomes.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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REFERENCES

1. Jayant SS, Gupta R, Rastogi A, Agrawal K, Sachdeva N, Ram S, et al. **Abdominal obesity and incident cardio-metabolic disorders in Asian-Indians: A 10-year prospective cohort study.** Diabetes Metab Syndr. 2022; 16(2):102418. doi.org/10.1016/j.dsx.2022.102418

2. Baig M, Gazzaz ZJ, Gari MA, Al-Attallah HG, Al-Jedaani KS, Mesawa AT, et al. **Prevalence of obesity and hypertension among University students' and their knowledge and attitude towards risk factors of Cardiovascular Disease (CVD) in Jeddah, Saudi Arabia.** Pak J Med Sci. 2015; 31(4):816-20. doi: 10.12669/pjms.314.7953

3. Dwivedi AK, Dubey P, Cistola DP, Reddy SY. **Association between obesity and cardiovascular outcomes: Updated evidence from meta-analysis studies.** Curr. Cardiol. Rep. 2020; 22:1-9. doi.org/10.1007/s11886-020-1273-y

4. Alam MJ, Ahmed I, Begum R, Jamil KA, Moinuddin S. **Evaluation of body mass index as a factor of outcome in coronary artery bypass surgery.** Cardiovasc. J. 2018; 10(2):150-57. doi:10.3329/CARDIO.V10I2.36283.

5. Elbaz-Greener G, Rozen G, Carasso S, Kusniec F, Yarkoni M, Marai I, et al. **The relationship between body mass index and in-hospital mortality in patients following coronary artery bypass grafting surgery.** Front Cardiovasc Med. 2021; 8:754934. doi.org/10.3389/fcvm.2021.754934

6. Li C, Han D, Xu F, Zheng S, Zhang L, Wang Z, et al. **Obesity paradox of all-cause mortality in 4,133 patients treated with coronary revascularization.** J. Interv. Cardiol. 2021; 3867735. doi.org/10.1155/2021/3867735

7. Schwann TA, Ramia PS, Engoren MC, Bonnell MR, Goodwin M, Monroe I, et al. **Evidence and temporality of the obesity paradox in coronary bypass surgery: An analysis of cause-specific mortality.** Eur J Cardiothorac Surg. 2018; 54(5):896-903. doi.org/10.1093/ejcts/ezy207

8. Rezaee M, Fallahzadeh A, Sheikhy A, Jameie M, Behnoush AH, Pashang M, et al. **BMI modifies HDL-C effects on coronary artery bypass grafting outcomes.** Lipids Health Dis. 2022; 21(1):128. doi.org/10.1186/s12944-022-01739-2

9. Moon H, Lee Y, Kim S, Kim DK, Chin HJ, Joo KW, et al. **Differential signature of obesity in the relationship with acute kidney injury and mortality after coronary artery bypass grafting.** J Korean Med Sci. 2018; 33(48):e312. doi.org/10.3346/jkms.2018.33.e312

10. Takagi H, Umemoto T, **ALICE (All-Literature Investigation of Cardiovascular Evidence) Group. Overweight, but not obesity, paradox on mortality following coronary artery bypass grafting.** J. Cardiol. 2016; 68(3):215-21. doi.org/10.1016/j.jjcc.2015.09.015

11. Borracci RA, Ingino CA, Miranda JM. **Association of body mass index with short-term outcomes after cardiac surgery: Retrospective study and meta-analysis.** Medicina (Buenos Aires). 2018; 78(3):171-79.

12. Hällberg V, Kataja M, Lahtela J, Tarkka M, Inamaa T, Palomäki A. **W-CABG Study Group. Obesity paradox disappears in coronary artery bypass graft patients during the 20-year follow-up.** Eur. Heart J. Acute Cardiovasc. Care. 2017; 6(8):771-77. doi.org/10.1177/2048872616633844

13. Sabzi F, Faraji R. **Effect of body mass index on postoperative complications in beating coronary artery surgery.** Ethiop. J. Health Sci. 2016; 26(6):509-16. 10.43[14]/ejhs.v26i6.2

14. Basit A, Sabir S, Riaz M, Fawwad A. **NDSP 05: Prevalence and pattern of dyslipidemia in urban and rural areas of Pakistan; a sub analysis from second National Diabetes Survey of Pakistan (NDSP) 2016-2017.** J Diabetes Metab Disord. 2020; 19(2):1215-25. doi: 10.1007/s40200-020-00631-z

15. Matsuda M, Suzuki M, Ajiro Y, Shinozaki T, Sakagami S, Yonezawa K, et al. **Involvement of growth differentiation factor 15 in the paradoxical relationship between body mass index and mortality in patients with suspected or known coronary artery disease; The ANOX Study.** Eur. Heart J. 2022; 43(Supplement_2):ehac544-2391. doi.org/10.1093/eurheartj/ehac544.2391

16. Butt JH, Petrie MC, Jhund PS, Sattar N, Desai AS, Køber L, et al. **Anthropometric measures and adverse outcomes in heart failure with reduced ejection fraction: Revisiting the obesity paradox.** Eur. Heart J. 2023; 44(13):1136-1153. doi.org/10.1093/eurheartj/ehad083

17. Jones N, Ordonez-Mena JM, Roalfe AK, Goyder C, Hobbs FD, Taylor CJ. **Body mass index and survival in people with heart failure.** Eur. Heart J. 2022; 43(Supplement_2):ehac544-894. doi: 10.1136/heartjnl-2023-322459

18. Gurevitz C, Mohsen J, Ovdat T, Zwas DR, Fluk Gmach S, Beigel R, et al. **The obesity paradox in patients with acute coronary syndromes–is it still applicable to the current era?** The ACSIS registry 2000-2018. Eur. Heart J. 2022; 43(Supplement_2):ehac544-1302. doi.org/10.1093/eurheartj/ehac544.1302

19. Narasimhan B, Ho K, Wu L, Amreia M, Isath A, Bhatia K, et al. **Impact of age on the obesity paradox in acute coronary syndrome: A nationwide analysis.** Eur. Heart J. 2020; 41(Supplement_2):ehaa946-1359. doi.org/10.1093/ehjci/ehaa946.1359

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3	Azam Jan	Final approval.	
4	Saif Ullah	Review manuscript.	
5	Muhammad Salman Farsi	Data collection.	
6	Muhammad Imran Khan	Manuscript writing.	
7	Nasir Ali	Editing.	
8	Rashid Qayyum	Statistical analysis.	